United States
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Agricultural
Research
Service

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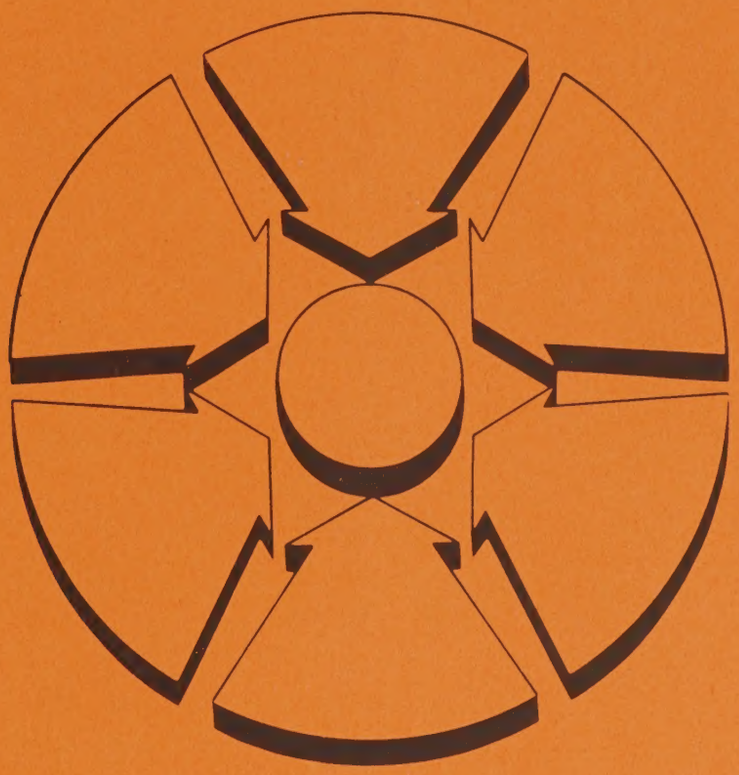
Agricultural Research Service Program Plan

6-Year Implementation Plan, 1986-1992



Contents

This publication supersedes "Agricultural Research Service Program Plan: 6-Year Implementation Plan, 1984-1990," issued February 1983.

Introduction

The Agricultural Research Service (ARS) began strategic planning nearly 4 years ago. The results of that effort are summarized in the "Agricultural Research Service Program Plan,"[1]/ which describes the goal, objectives, and broad research approaches that ARS--within the scope of its mission--will pursue in future years to help assure the continuing vitality of U.S. agriculture.

To guide in implementing these future research approaches, ARS revised its management philosophy and formulated new policies, according to which it produced a 6-year implementation plan.[2]/ This plan identified the key strategies that ARS expected to follow during the planning period 1984-1990 and summarized the program priorities that ARS planned to use in resource allocation. It also identified the program changes for achieving the desired balance among the different objectives and approaches set forth in the ARS program plan.

In developing the 6-year plan, ARS considered that

- Federal funding support for ARS programs, when adjusted for inflation, had remained essentially constant since 1966.
- Problems facing agriculture constantly change and are increasingly complex and costly, as is the research needed to solve them.

The 6-year plan reflected the assumption that trends in these two conditions would continue for the near term, and it also reflected ARS' decision that it must allocate part of its available resources to address new initiatives and emerging problems.

During the past 2 years, the 6-year plan served a number of useful functions. Primarily, it guided ARS scientists and administrators in developing new research thrusts. In consultation with the ARS National Program Staff (NPS), many scientists reoriented their efforts to higher priority problems and/or developed new research approaches. The 6-year plan guided the NPS and others during budget development, allocation

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1/ Agricultural Research Service Program Plan. U.S. Department of Agriculture, Agricultural Research Service, Miscellaneous Publication 1429. 1983.

2/ Agricultural Research Service Program Plan: 6-Year Implementation Plan, 1984-1990. U.S. Department of Agriculture, Agricultural Research Service. 1983.

of new resources, and redirection of funds in the recent ARS organizational realignment. The net effect of these changes has been to help ARS significantly improve its scientific and problem-solving capability.

An equally important function of the 6-year plan has been to increase the communication between ARS and the many individuals and groups it serves, for example, USDA and its various agencies, the Congress, agricultural and food industrial groups, cooperating agencies, and scientists. The increased communications and sharing of ideas that resulted from publishing the 6-year plan have made ARS research programs more relevant and effective in addressing problems.

This document is the second 6-year implementation plan and covers the period 1986-1992. It was prepared for several specific purposes:

- Continue to foster communications between performers, users, and supporters of agricultural research.
- Describe the changes in ARS policies and priorities that have occurred during the past 2 years.
- Document both the progress made in implementing planned funding changes in ARS programs since 1982 and the use of new or redirected resources.
- Reaffirm and update broad research strategies and future areas of research that ARS will emphasize.
- Document minor modifications in the ARS classification structure made during the past 2 years and, thus, to more accurately describe the Agency's programs.
- Continue to improve the relevance and effectiveness of ARS national research programs.

Each of these points will be discussed more fully in subsequent sections.

Implementation Strategies

In the first implementation plan, three strategies were described. Briefly stated, they were to emphasize (1) mission-oriented research, (2) integrative systems research, and (3) research to increase the efficiency of production and marketing. Major problems and factors indicating the need for these strategies and resulting priorities were increasing world food needs, declining quantity and quality of natural resources, declining rate of growth in agricultural productivity, continuing surpluses of many commodities, and static stores of fundamental knowledge.

Although these problems remain, other national problems of concern to ARS have also become critical:

- Declining competitive position of U.S. agricultural products in international markets and increasing surpluses of many commodities. Whereas U.S. exports were rising and reached about $44 billion in 1981, they are now falling and are projected at only about $35 billion for 1985. Costs of production and marketing must be reduced and product acceptability and quality must be improved if U.S. agricultural products are to be competitive in world markets.

- Threat of low profitability and return on investment to significant numbers of farmers, the businesses that supply and finance them, and the rural communities in which these people trade and live. Net farm income in 1984 and 1985 is being compared with that of the 1930's depression era.

- Continuing vulnerability of U.S. food and fiber security to weather and long-term depletion of nonrenewable resources. Soil erosion continues to diminish water-storage capacity and productivity of soils and causes serious downstream silting of streams and water impoundments.

- Continuing perception that agricultural chemicals, sediments, and biotoxins are environmental hazards. Potential contamination of ground-water supplies by toxic chemicals and naturally occurring elements is of particular concern.

- Increasing consciousness of both domestic and foreign consumers that the quality, nutritional value, and safety of U.S. agricultural products must be maintained. Agricultural production and processing research has not yet been firmly linked to human nutrition research and food needs.

- Unacceptably high losses of agricultural commodities during production, harvesting, transport, processing, and marketing.

None of these problems can be solved by research alone. Economic, political, and policy factors are involved in all of them, especially the export market problems. Nevertheless, ARS will address these problems to the extent that research can contribute to their solution and to the extent that resources are available. As the national agricultural research agency, ARS must concentrate available resources on the most critical national problems--particularly those not being adequately addressed by other research organizations.

Faced with both continuing resource constraints and the complex problems indicated, ARS revised the previous strategies and arrived at four strategies for the 1986-1992 period.

Strategy 1

ARS Will Address Technical Problems That Are Determined To Be the Most Critical to the U.S. Food and Agricultural Sector and That Are Within the Scope of ARS Capabilities, Resources, and Mission.

This strategy addresses the issues of program relevance and effectiveness. As a Federal agency, ARS must concentrate its resources on problems of broad scope and national concern. Through continuous program oversight, review, and evaluation, the NPS assesses progress, ensures that resources are properly allocated to relevant high-priority programs, and recommends to the Administrator necessary changes in program direction and balance. To help guide strategic planning, ARS has increased its communications with research user groups and policymakers.

Besides identifying needs, ARS must provide resources to fill those needs. The technical problems of modern agriculture are much more complex and difficult to solve than those of the past. Solving such problems requires the use of up-to-date science and equipment with an interdisciplinary approach. Therefore, ARS must focus more resources on fewer problems to maximize the probability of success and make the most effective use of those resources. Also, ARS must select and attack the problems of greatest national concern. The following conditions are examples of such a concern:

- A recent analysis of a number of problems associated with the poor competitive position of U.S. agricultural products in world markets showed that we have little fundamental knowledge of product quality. Such knowledge is necessary if we are to develop new products and technologies that can compete with those of other exporting countries.

- While we have the skills needed to transfer genes between organisms, we lack knowledge as to which genes to transfer and hence are limited in applying these skills to agricultural problems. Mapping these genes and determining their functions are tasks for which the private sector generally lacks resources, skills, and incentives.

- We have underutilized the approach of using interdisciplinary teams for problem solving. Such teams are needed to develop the agricultural management systems that can reduce production costs, maintain or improve product quality, reduce losses of products, and conserve soil and water resources.

Strategy 2 **ARS Will Allocate Resources To Solve Specific High-Priority National Problems.**

This strategy addresses the need for ARS to use its resources efficiently. After priorities at the national level have been determined, resources must be channeled to the right places in a timely way. As research projects are completed, resources are redirected by NPS to high-priority problems. Program implementation is based on two main approaches.

The first approach is to conduct annual indepth analyses of the research capabilities and resource needs of every laboratory, research unit, and other operating units in the Agency, including administrative groups. This approach, first implemented in 1984, is called ARMS.3/ The products of ARMS represent an annual plan to conduct the research program consistent with the allocation of resources.

The second approach to operational planning is to conduct planning workshops and indepth reviews of specific programs, problem areas, and laboratories. These workshops and reviews typically involve leading scientists from the disciplines

3/ The ARS Resource Management System (ARMS). U.S. Department of Agriculture, Agricultural Research Service. 1985.

and research units working on the program or problem. Also included are cooperators from other research organizations and representatives from industry, action agencies, universities, Extension, and other appropriate user groups. These individuals evalulate research progress and current allocation of funds, identify priorities, and make recommendations to NPS and line administrators regarding research needs and program direction.

Working together, people from the different operating levels of ARS--NPS, area directors, administrative specialists, and scientists--use the results of operational planning in the following ways:

- Adjust distribution of scientific and financial resources within and among laboratories to ensure a properly balanced national program in terms of disciplines, research approaches, commodities, physiographic regions, fundamental research, technology transfer, and other considerations, such as facility maintenance.

- Identify needs and allocate resources for new research approaches or new expertise (for example, computers and systems science, new techniques from biotechnology, and improved equipment and facilities) to increase the rate of progress or probability of success.

- Assure coordination of similar or interrelated research projects both within ARS and between ARS and other research organizations to avoid unnecessary duplication, ensure complementarity, and speed progress.

- Increase resources for the highest priority problems, as set forth in strategy 1, but at the scientific or technical level.

- Provide central control and overview of all resources to ensure national program coordination and accountability for the intended and best use of public funds.

- Review and evaluate all scientific and administrative activities within ARS annually.

Strategy 3 **ARS Will Place Increased Emphasis on Using Interdisciplinary Teams for Problem Solving.**

This strategy addresses the need to obtain the right kinds of scientific expertise and proper level of resources to solve

problems. As indicated in strategy 1, the problems of contemporary agriculture are complex. The days of major research contributions from individual scientists working in isolation are largely over. Scientists working together innovatively in teams are required to accelerate research progress and ensure a comprehensive approach to solving problems; and the scientists must be rewarded appropriately for their contributions to the teams. Interdisciplinary teams could, for example, integrate expertise from emerging areas of biotechnology into traditional genetics research; reduce potentially adverse effects of crop production and protection practices on ground-water quality; and determine the effects of production and protection practices on the safety, nutritional quality, and other important characteristics of major agricultural products.

ARS has taken various steps to increase the number of interdisciplinary teams within the Agency. These include transfer of scientists, redirection of funds and scientists, and recruitment of scientists in critical disciplines.

To attract new ideas and expertise, the Administrator recently initiated a research associate program which, in 1985, provided funds for 50 young scientists to work with ARS scientists, mainly in emerging areas of bioscience. ARS also provides considerable opportunity for scientists to obtain specialized skills and training of various kinds, including a modest program for training Ph.D. agricultural engineers. To obtain specialized expertise for short-term projects, ARS may enter into contracts and agreements with universities or may work cooperatively with other Federal agencies, such as the Soil Conservation Service (SCS). The latter arrangement is particularly valuable for ensuring technology transfer and application of research results. ARS will use all these mechanisms to expand its spectrum of vital talent and increase the efficiency of its research programs.

Strategy 4 **ARS Will Foster the Development of Communication Networks and Data-Management Systems To Support Its Research Programs and Facilitate Technology Transfer.**

This strategy continues to foster the use and development of computer-based information and data-management systems and networks in ARS. Communications networks allow scientists of different disciplines and at different locations to readily share their knowledge and their research ideas and results. These same networks are used to transfer new technology to

Extension and other user agencies and will eventually deliver information and decision support services directly to farmers and ranchers.

Data-management systems now support the development of both modeling and expert systems in agriculture. Computer models of crop and animal production, soil erosion, and other systems are becoming useful vehicles for expressing the state of the art of many areas for scientific research. Expert systems can combine models and data from many disciplines and then integrate the massive quantities of knowledge into manageable decision support systems for users of research. Agriculture is rapidly moving toward using both models and expert systems on the farm, in Government, and in business transactions.

During the past 2 years, ARS made significant progress in changing the program balance among the different areas of research. Figure 1 shows the current balance of funding among the six major objectives of ARS.

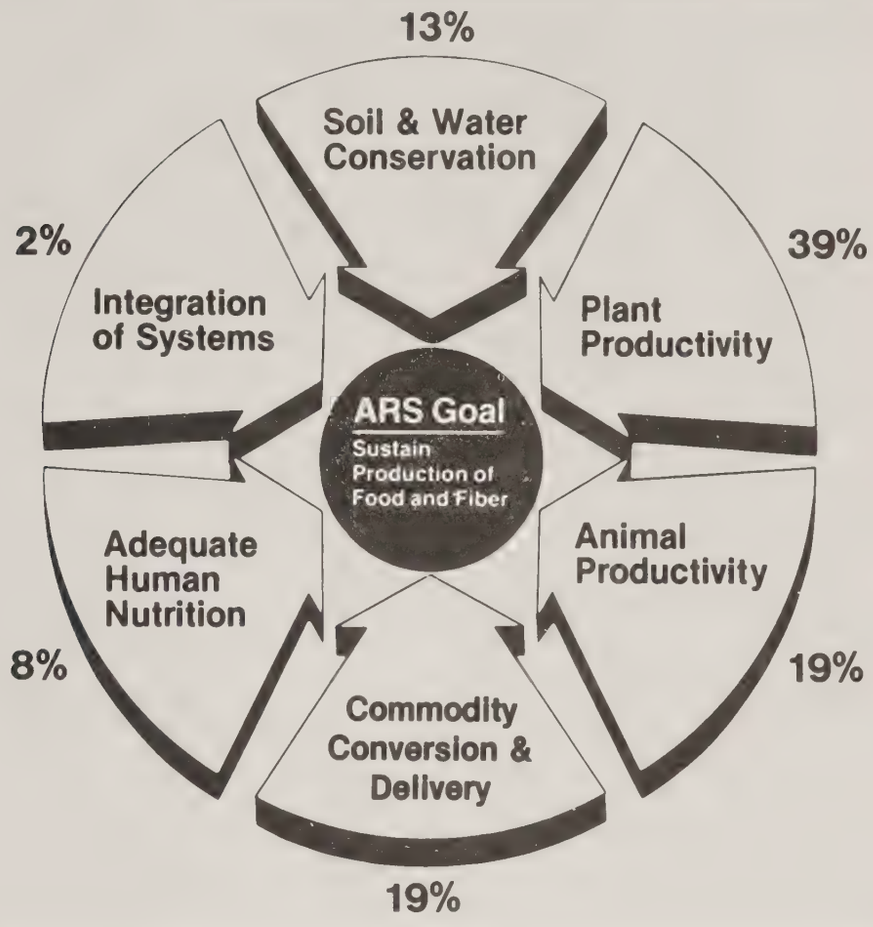

Figure 1. Distribution of funds among objectives of the ARS program in 1985.

As indicated in the first 6-year implementation plan, ARS planned to adjust its program incrementally through internal management and budgetary processes. Since 1982, the program balance for the objectives that address human nutrition and commodity conversion and delivery have been increased one percentage point each, whereas the balance for the objectives dealing with plant and animal productivity have declined one percentage point each.

Figures 2 through 7 show how the funds within each objective are distributed among the various research approaches and

approach elements set forth in the ARS program plan. (Complete titles of these classification structures are given in the appendix.)

To interpret the data in the figures, two facts are important. First, the ARS budget increased by $61.2 million during the past 3 years. Second, the Agency saved approximately $12 million by reducing administrative costs and restructuring the organization. The funds from both sources were used selectively to increase the support of high-priority projects. As a result, the funding levels for all objectives increased, even those showing a lower percentage than before. For example, funds for plant productivity were increased by nearly $22 million since 1982 in support of germplasm enhancement, biocontrol of pests, and other high-priority problem areas.

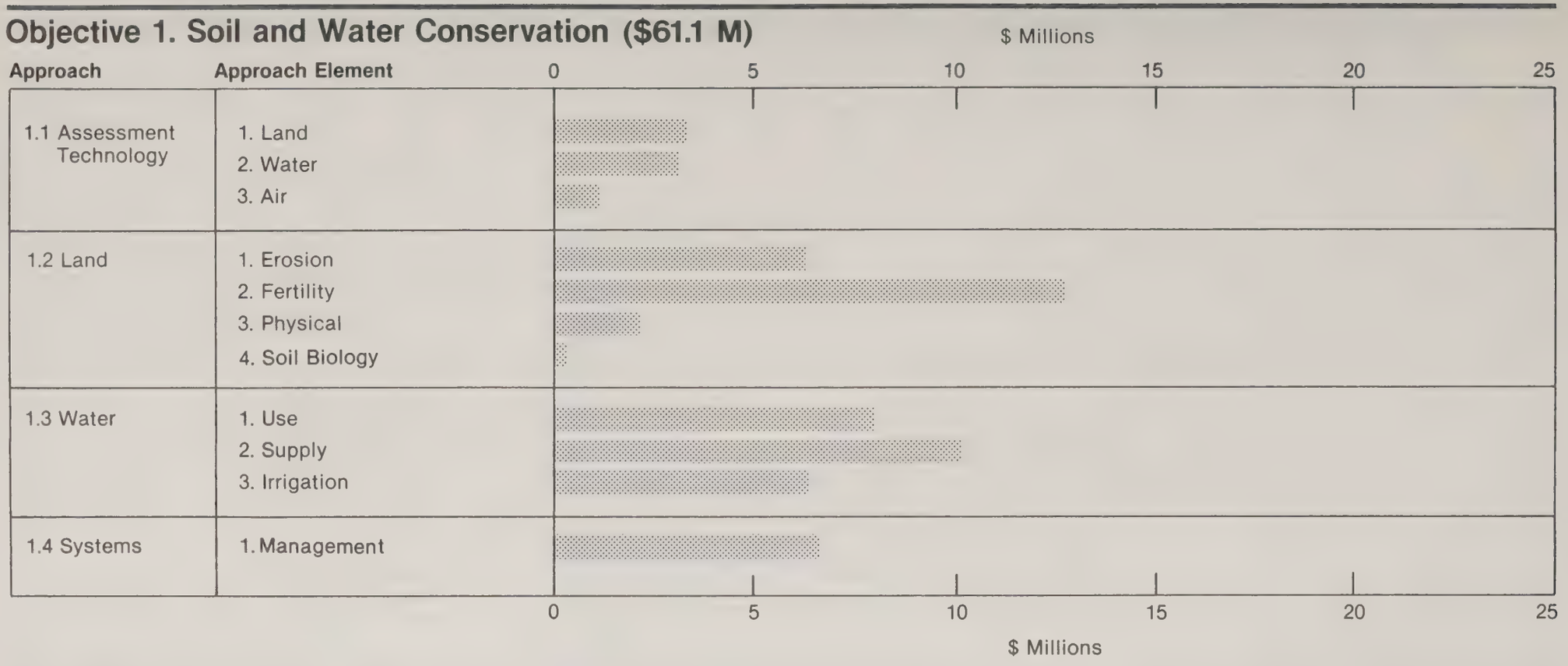

Figure 2. Present approach element allocations for soil and water conservation.

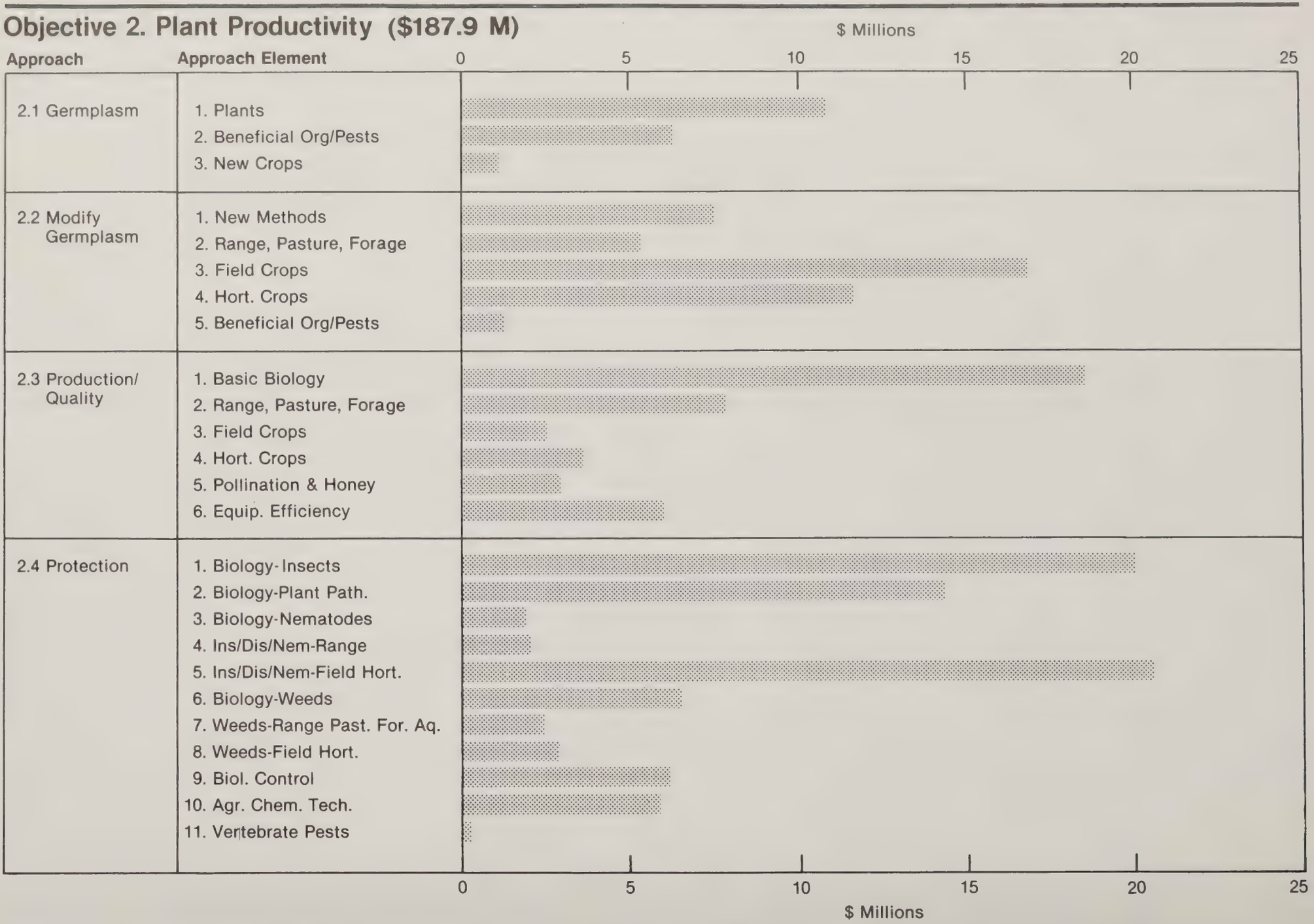

Figure 3. Present approach element allocations for plant productivity.

Objective 3. Animal Productivity ($90.1 M)

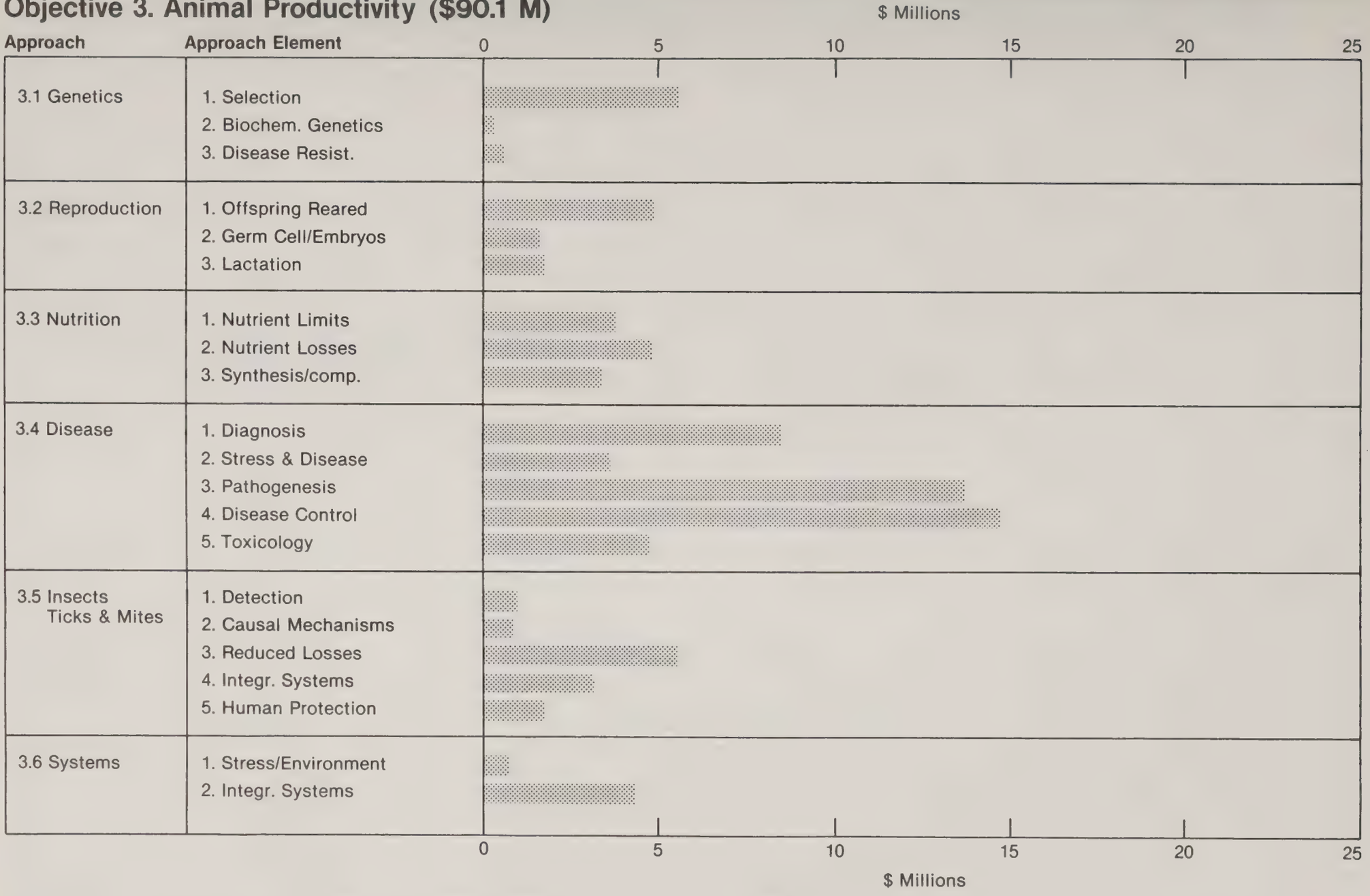

Figure 4. Present approach element allocations for animal productivity.

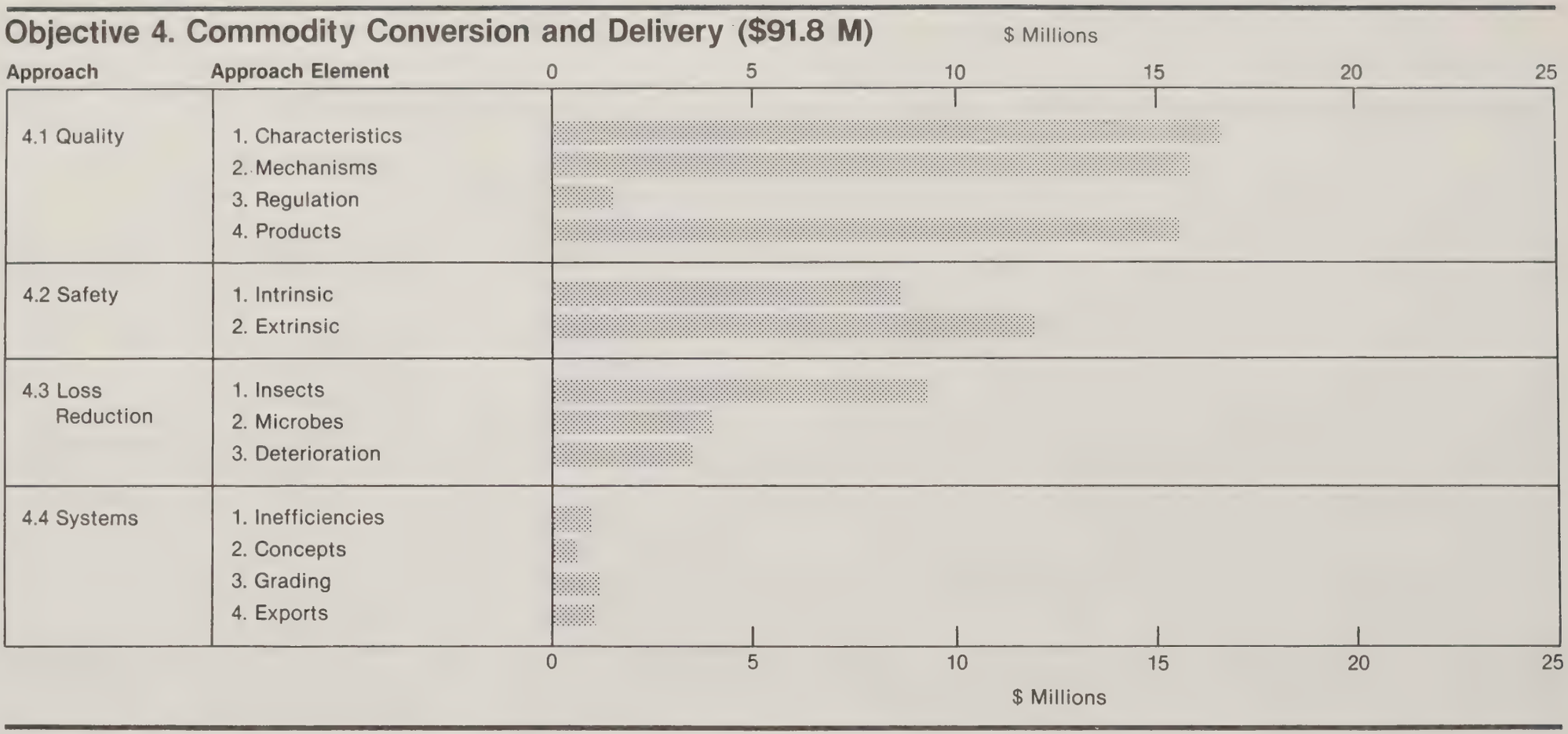

Figure 5. Present approach element allocations for commodity conversion and delivery.

Objective 5. Adequate Human Nutrition ($36.7 M)

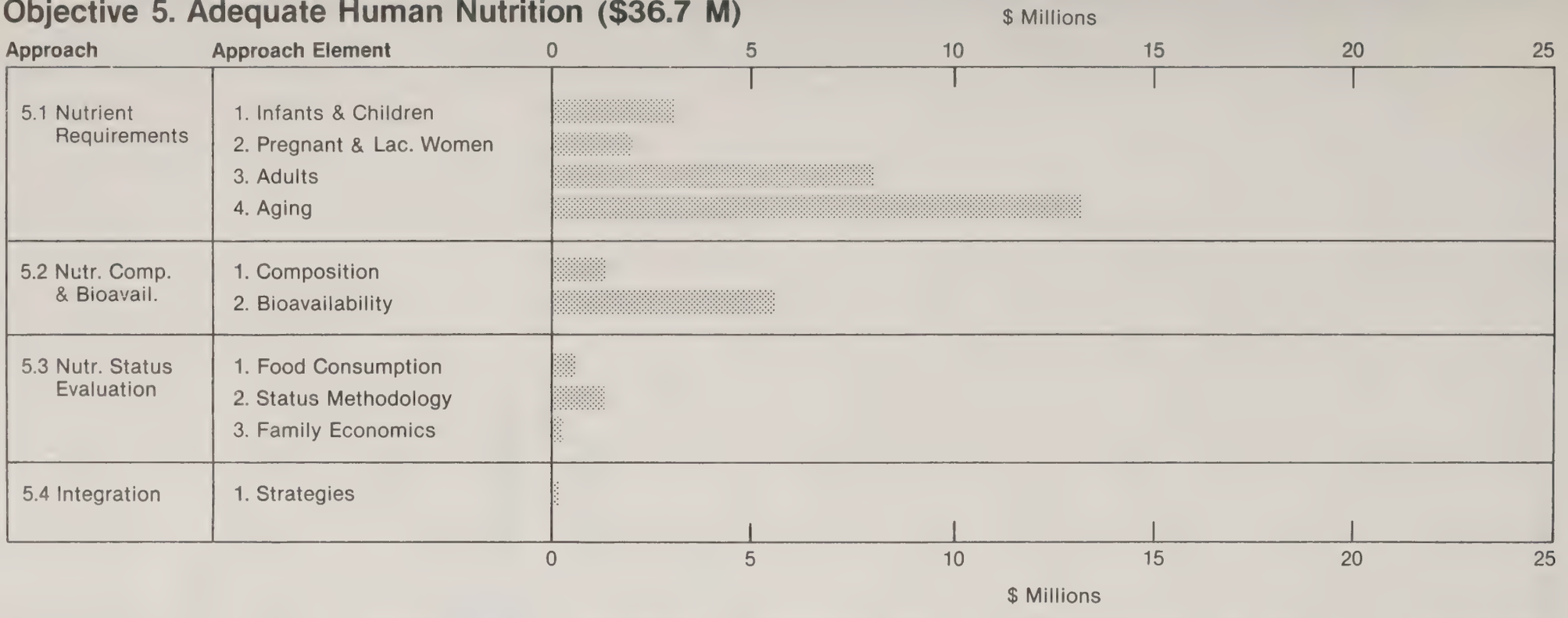

Figure 6. Present approach element allocations for adequate human nutrition.

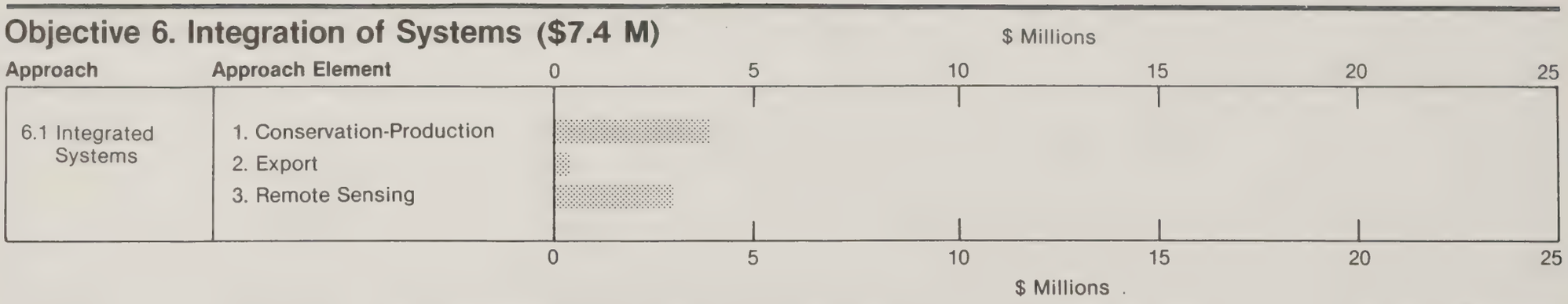

Figure 7. Present approach element allocations for integration of systems.

ARS will continue to make needed adjustments in the balance among program objectives. As discussed in the preceding sections, ARS must respond to a number of urgent needs. The first requirement is to address complex problems, such as high production costs, commodity surpluses, declines in exports, and human nutrition. The second requirement is technical. As a scientific organization, ARS must stay at the forefront of science so that it can deal effectively with agricultural problems. ARS scientists must be provided with modern equipment, techniques, and research facilities.

Figure 8 shows the ARS program balance projected to 1992. Modest increases are planned for the objectives dealing with resource conservation, commodity conversion and delivery, human nutrition, and systems integration. The proportion of funds for the animal productivity objective is already on target. However, this objective as well as all others includes specific problem areas that are to receive greater emphasis as opportunities permit and resources become available.

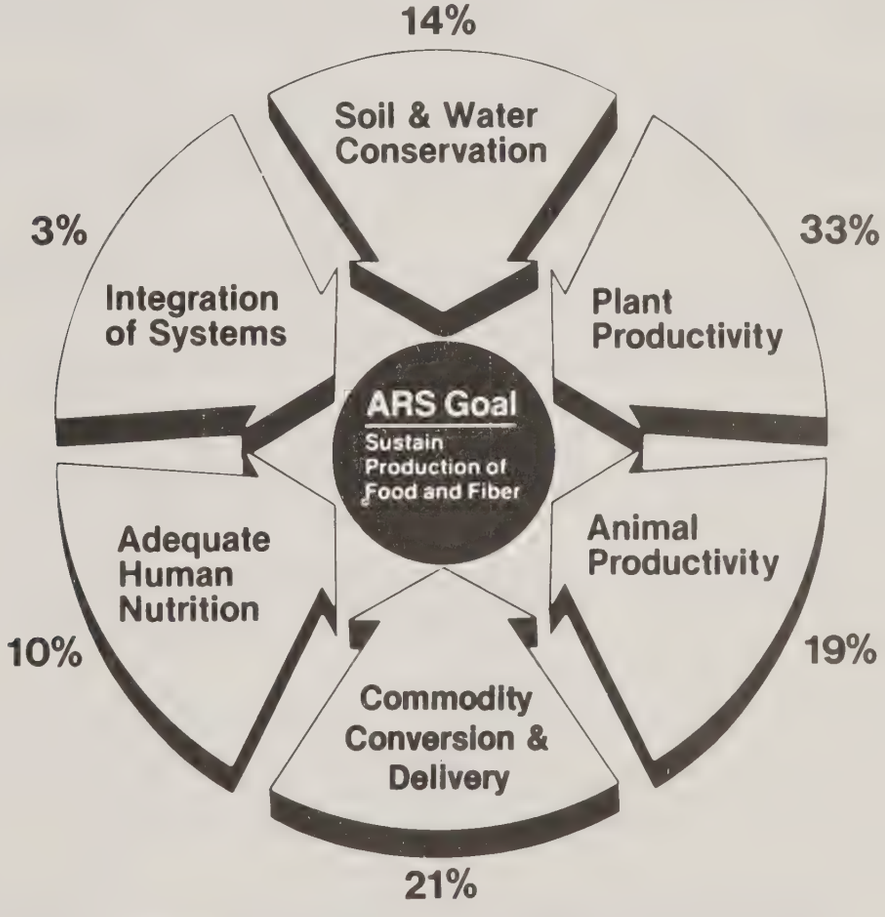

Figure 8. Planned distribution of funds among objectives of the ARS program in 1992.

The high-priority needs for each objective are outlined below:

1. Soil and Water Conservation

- Improved technology for preventing or reducing ground-water contamination by agricultural chemicals.
- Effective measures for controlling salinity and toxic elements in irrigation and drainage waters in the West.
- Efficient and accurate methods for assessing the condition of the soil and water resource base.
- New and improved methods for assessing and reducing offsite damages associated with runoff and erosion from croplands and rangelands.
- Improved techniques and strategies for predicting and controlling soil erosion caused by wind and water.
- Strategies for adapting agriculture to dryland conditions as water supplies decline or increase in cost.
- Improved management of agriculture's water resources.
- Methods for improving the efficiency of fertilizer use and the bioavailability of plant nutrients.
- Fulfillment of the highest priority research needs of the SCS and other USDA agencies.
- Knowledge of the transport, fate, and effectiveness of agricultural chemicals in conservation tillage systems.
- Methods for evaluating the effects of residue decomposition on crop growth and soil erodibility.

2. Plant Productivity

- Technologies for lowering production costs and improving product quality.

- Expanded capabilities for preserving, evaluating, and enhancing germplasm.

- Technologies for gene transfer and expression.

- Methods for controlling the fundamental biological processes related to crop growth, environmental stresses, plant-pest interactions, and yield potential.

- Knowledge of the fundamental mechanisms governing the behavior and biology of destructive and beneficial organisms.

- Biocontrol technologies for major crop pests.

- Improved and innovative technologies for pest control and management.

- Innovative and efficient methods for pesticide application.

- Research support for SCS, the Animal and Plant Health Inspection Service (APHIS), and other USDA agencies.

3. Animal Productivity

- Physiological and biochemical approaches for controlling genetic variation and resistance to diseases, parasites, and arthropods.

- Knowledge of how specific genes improve production and reproduction efficiency and animal product quality.

- Integrated management systems for controlling livestock pests.

- Methods for reducing fat and increasing protein tissues in animals and animal products.

- Knowledge of ways to apply recombinant nucleic acid technologies to diagnose foreign and domestic diseases, parasites, and arthropods.

- Techniques for producing subunit antigens to control and prevent diseases.

- Knowledge of how stress relates to disease etiology and reduced production efficiency in livestock and poultry.

- Methods for determining effects of mycotoxins on animals.

- Research support for APHIS, Food Safety and Inspection Service (FSIS), and other action agencies.

4. Commodity Conversion and Delivery

- Knowledge of ways to apply new and emerging technologies to convert surplus commodities and their derivatives into competitive or novel products which can open new foreign and domestic markets, displace imports, or add value. Surpluses emphasized for conversion are corn, milk, wheat, and soybeans and such derivatives as starch, casein, and vegetable oil. Target conversion products include bulk feedstock chemicals, value-added polymers and specialty chemicals, and high-value imports.

- Methods for genetically and metabolically controlling the quality parameters of plant and animal raw agricultural commodities and products. Especially needed are means to control the biodeterioration of fresh and lightly processed fruits and vegetables so that lucrative domestic and foreign produce markets may be expanded.

- Means for preventing mycotoxin development in crops in the field or in storage, particularly the major crops in the export trade and domestic market.

- Research support for USDA action agencies such as APHIS, FSIS, and Federal Grain Inspection Service (FGIS) to develop alternatives to fumigation, objective methods of grading, and improved methods for controlling insects, pathogens, and spoilage agents in food supplies.

5. Adequate Human Nutrition

- Knowledge of how food production and processing practices relate to human nutritional needs.
- Improved knowledge and specification of nutritional requirements for infants, children, pregnant and lactating women, and the elderly.
- Improved understanding of the relationships between nutrition and aging.
- Improved methods for analyzing and determining the bioavailability of nutrients in foods.
- Methods for assessing nutritional status.
- Improved understanding of the relationship between diet and health maintenance.
- Fulfillment of the highest priority research needs of the Human Nutrition Information Service (HNIS), Food and Nutrition Service (FNS), and other action agencies.

6. Integration of Systems

- Conservation-production systems for major physiographic regions, such as the Great Plains, Corn Belt, Coastal Plain, Delta, and western rangelands.
- Remote sensing technologies for helping SCS, Statistical Reporting Service, Agricultural Stabilization and Conservation Service, and Foreign Agricultural Service improve natural resource assessments and crop inventories.
- Production-marketing systems for increased exports of major agricultural commodities.
- Systems and models for reducing the costs of production, processing, and marketing.
- Models for assessing and predicting potential adverse environmental effects of agricultural practices, such as impaired water quality.
- Specialized computer-aided expert systems for helping farmers and action agencies make timely decisions.

Operational Planning in ARS

The purpose of this section is to help interpret the 6-year plan for 1986-1992, describe how ARS establishes priorities, and discuss how resources will be deployed to address the highest priority national problems.

Improving and sustaining the productivity of the food and agricultural systems will remain the overall research goal in ARS. The term "productivity" relates to more than yield or quantity. Some of the most important gains in productivity are to be achieved by reduced production costs and improved commodity quality, value, and utility. The potential benefits of gains in productivity are threefold: increased net farm income, increased share of world markets, and reduced surpluses of agricultural commodities. For the near term, one of the most significant contributions that research can make is to reduce production costs. Therefore, accelerated research on efficiency factors must be among the highest national priorities.

The sustainability of agriculture depends upon more effective conservation of nonrenewable resources than has been achieved in the past. Research emphasis on these resources is needed to preserve their productivity for future generations.

While excess production capacity is a burden on most U.S. producers and the general economy--and will be for the foreseeable future--that extra capacity also allows ARS to allocate a greater proportion of its scientific capability to obtaining the new knowledge and skills needed for solving the problems that cannot be solved with existing technology. This approach will help U.S. agriculture in the marketplace, where world competition is expected to increase into the 21st century.

ARS program managers do not make changes or set priorities in isolation. Soliciting expressions of research needs from a spectrum of user groups is an integral part of strategic and operational planning. ARS strives continuously to meet the research needs of action and regulatory agencies, commodity groups, industrial organizations, and many other private-sector groups. In 1984-1985 ARS scientists had over 60,000 contacts with industry representatives. In that same period NPS and other management personnel met with over 150 user-groups representatives. This productive relationship with agribusiness and representatives of farmers and ranchers is a continuing one.

ARS has also participated in and sponsored numerous scientific workshops, conferences, and other meetings to identify high-priority problems and research needs. Important in the priority-setting process are administration policies and the counsel of the Secretary of Agriculture and the Congress.

Plans and priorities must be dynamic to reflect changing needs and opportunities, and NPS continually reviews and assimilates information from diverse sources. With this information, NPS systematically evaluates needs in terms of the ARS mission, national importance of the identified problems, roles and capabilities of other research organizations, limits of available ARS resources, and the current status of research projects and programs. Then, NPS uses these evaluations to establish priorities, set targets for the next 6-year implementation plan, and allocate resources for an effective and relevant program.

A basic purpose of the 6-year implementation plan for 1986-1992 is to allow ARS to achieve a realistic and functional balance among competing needs and opportunities. All six objectives and their component parts of the ARS program are recognized as important in agricultural research. However, some are judged to have more than their share of ARS resources in light of other pressing needs, limited ARS resources, and programs of other performers of agricultural research. As the funding levels for the research approaches and elements are determined by NPS to be in balance, all will be treated as high priorities and supported as resources permit. The same is true for different crop and animal commodities and for other subject-matter areas important to various users of ARS research results. However, the profile of the kinds of research supporting any given commodity or problem area may well change as the needs of the Nation and industry change or as advances in technology provide new opportunities to solve long-standing problems.

Program changes in ARS are being made and will continue to be made in an orderly and systematic way. Several factors make this possible. The areas of emphasis in any ARS 6-year implementation plan are the basis for developing the Agency's annual budget. While budget increases in 1982-1985 were modest--aproximately equal to the rate of inflation--most of the increases were targeted for high-priority research areas. Such increases not only minimize the need to shift base funds and personnel among program areas but also provide the flexibility to obtain new expertise and equipment.

Normal project turnovers also provide opportunities to make program changes. All research projects in ARS (approximately 3,000) have a maximum term of 5 years. Thus, in each year 20 to 25 percent of these projects are completed and terminated, and their resources can be allocated to other priority research areas or to new research approaches. Another set of opportunities is provided by the normal turnover of personnel. ARS employs approximately 2,600 scientists, and their yearly attrition rate is from 3 to 5 percent; therefore, each year ARS can fill about 100 positions with scientists having the skills needed to address the new problems identified and improve existing programs.

Once a problem or program direction is specified and funds are allocated by NPS, project scientists are responsible for determining the scientific approach and experimental procedures best suited for carrying out the research. Operational planning provides a two-pronged approach for ensuring scientific excellence and research progress. Resource needs and research opportunities in every project and research unit are assessed annually by the scientists, research leaders, laboratory, area directors, and NPS. Periodically, research needs and opportunities are assessed by staff, leading scientists, and other experts across broad problem areas and research approaches to ensure national coordination and program balance. These two review processes give ARS scientists a chance not only to identify emerging high-priority problems but also to indicate to NPS and line administrators their desire and ability to help solve those problems.

Synopsis

The net effects of the first 6-year implementation plan have been to emphasize the high-priority national problems facing agriculture, direct increased financial and scientific resources to those problems, and focus on new approaches for their solution. By making selective use of budget increases, funds from redirection, and administrative savings, ARS is making certain desired changes. Many of the critical ones, such as increased emphasis on biotechnology, germplasm enhancement, human nutrition, and systems approaches, are being made faster than anticipated. Moreover, the changes are toward problems identified as high priority by research users, policymakers (including members of Congress), and the scientific community.

The second 6-year implementation plan provides for updating the program changes set in motion by the first 6-year plan, guiding the implementation of ARS strategies, and helping ARS maintain good communications within the organization and with research users and policymakers. Communications of this kind have helped speed the validation and updating of ARS plans. ARS will continue to solicit inputs from the users of its research and will respond to those inputs the best it can with the resources available. ARS will periodically issue a revised and updated 6-year implementation plan as research progresses and priorities change.

Appendix
ARS Objectives, Approaches, and Approach Elements

Objective 1 — **Develop the Means for Managing and Conserving the Nation's Soil and Water Resources for a Stable and Productive Agriculture.**

Approach 1.1 Develop the Technology for Assessing and Predicting Long-Term Changes in the Quantity and Quality of Soil, Water, and Air Resources Available to Agriculture.

Approach Elements

1.1.01 Develop improved techniques and systems for assessing, predicting, and monitoring changes in the productive capacity of land and soil resources.

1.1.02 Develop improved techniques for assessing and predicting water supplies and their quality, potential flood damages, and water-use efficiency.

1.1.03 Develop improved techniques for assessing and predicting the effects of weather and air quality on agricultural productivity and crop losses.

Approach 1.2 Provide the Technology Needed for Improving, Protecting, and Restoring the Productive Capacity of Agricultural Soils.

Approach Elements

1.2.01 Develop cost-effective conservation technologies for controlling soil loss from croplands and rangelands.

1.2.02 Devise methods for improving, maintaining, and restoring soil fertility and soil chemical properties for optimum and sustained crop production.

1.2.03 Devise techniques for improving, maintaining, or restoring the physical conditions of soils that are needed for optimum and sustained crop production.

1.2.04 Devise technologies to utilize soil biological processes for improving the efficiency of crop production and preventing environmental degradation.

Approach 1.3 Develop Improved Water Management Systems and Practices To Achieve Effective and Efficient Use of Water Resources.

Approach Elements

1.3.01 Develop improved techniques for optimizing the use of water by plants in irrigated and nonirrigated croplands and rangelands to increase water-use efficiency and stabilize productivity.

1.3.02 Develop methods for increasing, conserving, and managing water supplies available for agriculture, for improving water quality, and for reducing cropland damage from flooding.

1.3.03 Improve technology for storing and distributing water supplies efficiently and for improving irrigation, drainage, and salinity-control systems and practices.

Approach 1.4 Develop Improved Subsystems and Models That Integrate the Use of Soil, Water, and Air Resources for Optimum Management of Major Land Resource Areas.

Approach Elements

1.4.01 Develop improved systems and models for designing resource management strategies that optimize agricultural production and resource conservation and are compatible with environmental quality goals.

Objective 2	**Develop the Means for Maintaining and Increasing the Productivity and Quality of Crop Plants.**

Approach 2.1 Broaden the Germplasm Resources of Plants and Beneficial Organisms To Ensure Maximum Genetic Diversity for Improved Productivity.

Approach Elements

2.1.01 Collect, classify, evaluate, preserve, and distribute plant germplasm and assess its potential for meeting agricultural and industrial needs.

2.1.02 Collect, classify, evaluate, preserve, and distribute germplasm of beneficial organisms and strains of pests that are valuable in pest-management programs.

2.1.03 Collect, evaluate, and utilize new crop species for meeting agricultural, industrial, and medicinal needs.

Approach 2.2 Select and Modify Germplasm of Plants, Beneficial Organisms, and Pests.

Approach Elements

2.2.01 Devise new methods for modifying germplasm of plants, beneficial organisms, and pests.

2.2.02 Improve genetic populations of range, pasture, forage, and turf.

2.2.03 Improve genetic populations of field crops.

2.2.04 Improve genetic populations of horticultural and specialty crops.

2.2.05 Improve genetic populations of beneficial organisms, and develop strains of pests that will be useful in pest-management programs.

Approach 2.3 Develop Improved Production Practices for Maintaining and Increasing Crop Productivity and Quality and for Reducing Costs.

Approach Elements

2.3.01 Expand knowledge of plant growth and development processes of crop species and micro-organisms of agricultural importance.

2.3.02 Develop ecological principles and improved cultural and management practices for range, pasture, and forage.

2.3.03 Develop ecological principles and improved cultural and management practices for field crops.

2.3.04 Develop ecological principles and improved cultural and management practices for horticultural and specialty crops.

2.3.05 Develop improved methods of pollination and honey production.

2.3.06 Develop criteria and specifications for improving the efficiency of agricultural production and protection equipment and practices.

Approach 2.4 Develop Improved Methods for Reducing Crop Losses Caused by Weeds, Diseases, Insects, Nematodes, and Other Pests.

Approach Elements

2.4.01 Develop knowledge of growth, development, and behavioral and population processes of insects as a basis for discovering control principles.

2.4.02 Develop knowledge of etiology, epidemiology, and pathogenicity of plant pathogens as a basis for discovering control principles.

2.4.03 Develop knowledge of growth, development, and behavioral processes of nematodes as a basis for providing control technology.

Approach Elements

2.4.04 Provide technology for protecting range, pasture, forage, and turf from losses caused by insects, nematodes, pathogens, and other pests.

2.4.05 Provide technology for protecting field and horticultural crops from losses caused by insects, nematodes, and pathogens.

2.4.06 Develop knowledge of the biology of weeds for determining their vulnerability to control.

2.4.07 Develop control technology for reducing losses caused by weeds in forage crops, pastures, rangelands, turf, aquatic environments, and noncroplands.

2.4.08 Develop control technology for reducing losses caused by weeds in field and horticultural crops.

2.4.09 Develop fundamental principles of biological control for pests of crop plants.

2.4.10 Develop agricultural chemical technology for reducing crop losses and for modifying plant growth for improved crop protection and production.

2.4.11 Develop technology for the control of vertebrate pests.

Objective 3	Develop the Means for Increasing the Productivity of Animals and the Quality of Animal Products.

Approach 3.1 Increase the Genetic Capacity of Animals for Production.

Approach Elements

3.1.01 Devise optimum selection and mating procedures for obtaining high levels of animal performance and improved product quality.

3.1.02 Determine genetic variation in biochemical, physiological, and behavioral traits of animals, and devise ways for using the information to accelerate genetic improvement.

3.1.03 Improve genetic resistance of animals to diseases and internal and external parasites.

Approach 3.2 Improve the Efficiency of Reproduction and Reproduction-Related Biological Processes.

Approach Elements

3.2.01 Increase the number of offspring reared per male and female maintained.

3.2.02 Increase efficiency of germ cell and embryo production, transfer, and storage and of techniques for producing more offspring of superior quality.

3.2.03 Increase efficiency and persistence of lactation and egg production.

Approach 3.3 Improve Animal Nutrition and Feed Efficiency To Increase Productivity and Product Quality.

Approach Elements

3.3.01 Remove nutrient limitations to production.

3.3.02 Reduce losses and inefficiencies in nutrient use, and explore alternative sources of nutrients.

3.3.03 Devise nutritional and physiological means for modifying the rate of synthesis and the composition of animal products.

Approach 3.4 Develop Ways To Prevent or Control Losses From Diseases, Parasites, and Toxicants and Other Substances That Limit Animal Performance and Reduce the Quality of Animal Products.

Approach Elements

3.4.01 Improve methods for diagnosing and identifying agents that cause losses, and improve methods for assessing those losses.

3.4.02 Establish the roles of environmental stresses and nutrition in losses from diseases and parasites.

3.4.03 Characterize the mechanisms by which animals become infected and are affected by diseases and parasites.

3.4.04 Devise new and improved methods for preventing or reducing death, morbidity, and other losses from diseases and parasites.

3.4.05 Prevent, control, or eliminate losses from natural or synthetic substances to which animals may be exposed.

Approach 3.5 Develop Means for Controlling Insects, Ticks, and Mites That Affect Animals and Humans.

Approach Elements

3.5.01 Improve methods of detecting infestations and assessing losses.

3.5.02 Examine mechanisms by which insects, ticks, and mites cause harmful effects.

3.5.03 Devise new and improved methods for reducing losses from insects, ticks, and mites that affect animals and humans.

3.5.04 Integrate control technologies into systems approaches for managing insects, ticks, and mites that affect animals and humans.

3.5.05 Develop means for protecting humans from insects and insect-borne diseases.

Approach 3.6 Devise Means for Improving and Integrating Procedures and Facilities for Production and Transport of Animals To Increase Productivity, Reduce Costs, and Minimize Stresses.

Approach Elements

3.6.01 Devise management practices to reduce or eliminate stress and maximize animal productivity and product quality.

3.6.02 Develop production systems that will integrate productivity elements according to various environmental conditions to optimize resource use.

Objective 4	Develop the Means for Achieving Maximum Use of Agricultural Products for Domestic Markets and Export.

Approach 4.1 Develop Means for Enhancing the Inherent Properties and Uses of Agricultural Materials.

Approach Elements

4.1.01 Characterize the basic, physical, chemical, and aesthetic properties of plant and animal materials that enhance their usefulness.

4.1.02 Identify the biological and biochemical mechanisms in plants and animals that affect properties of agricultural materials.

4.1.03 Devise means for regulating and controlling the biological processes that enhance usefulness.

4.1.04 Devise concepts for innovative and improved processes and products.

Approach 4.2 Develop the Means for Meeting Foreign and Domestic User and Regulatory Requirements Relating to Toxic Factors in Food, Feed, and Other Agricultural Products.

Approach Elements

4.2.01 Identify and develop the means for removing intrinsic toxic factors of practical significance.

4.2.02 Identify and develop the means for removing extrinsic toxic factors of practical significance.

Approach 4.3 Develop Means for Reducing or Eliminating Postharvest Losses Caused by Pests, Spoilage, and Physical and Environmental Damage.

Approach Elements

4.3.01 Develop improved methods for controlling losses caused by insect pests.

4.3.02 Develop improved methods for controlling losses caused by micro-organisms.

4.3.03 Develop improved methods for controlling losses caused by internal chemical and biological mechanisms.

Approach 4.4 Develop the Means for Increasing Efficiency of Systems for Processing, Handling, Storing, and Distributing Agricultural Products.

Approach Elements

4.4.01 Identify system inefficiencies.

4.4.02 Devise means for reducing or eliminating inefficiencies.

4.4.03 Devise means for efficiently classifying products for exchange in the marketplace.

4.4.04 Devise means for meeting domestic and foreign quarantine and other requirements that restrict movement and trade of products.

Objective 5	**Develop the Means for Promoting Optimum Human Health and Well-Being Through Improved Nutrition and Family Resource Management.**

Approach 5.1 Define the Nutrient Requirements of Humans at All Stages of the Life Cycle.

Approach Elements

5.1.01 Establish the nutrient requirements of infants, children, and adolescents.

5.1.02 Establish the nutrient requirements of pregnant and lactating women.

5.1.03 Establish the nutrient requirements of adult humans.

5.1.04 Establish the relationship between nutrition and aging.

Approach 5.2 Determine the Nutrient Content of Agricultural Commodities and Processed Foods as Eaten, and Establish the Bioavailability of Their Nutrients.

Approach Elements

5.2.01 Compile essential data on the nutrient contents of foods as consumed in the United States.

5.2.02 Determine bioavailability of nutrients in foods as consumed.

Approach 5.3 Improve the Nutritional Status of Humans and the Well-Being of Families by Making Techniques Available for Assessing the Effectiveness of Nutrition and Home Economics Programs.

Approach Elements

5.3.01 Provide means for improving understanding of dietary practices, food-consumption patterns, and their determinants through assessments.

5.3.02 Develop reliable, efficient, and inexpensive methods for defining nutritional status and evaluating nutrition action programs.

5.3.03 Develop methods for improving family economic stability and security.

Approach 5.4 Integrate Knowledge of Human Nutritional Needs Into the Food and Agricultural System.

Approach Elements

5.4.01 Devise strategies for changes in the food and agricultural system that will enhance human nutrition.

Objective 6	**Develop the Means for Integrating Scientific Knowledge of Agricultural Production, Processing, and Marketing Into Systems That Optimize Resource Management and Facilitate Transfer of Technology to Users.**

Approach 6.1 Develop Integrated Systems for Efficiently Producing, Processing, and Marketing Agricultural Products.

Approach Elements

6.1.01 Develop improved and alternative conservation and production systems and decision/predictive models for different climatic zones and farm enterprises.

6.1.02 Develop improved production-marketing systems and decision/predictive models that can help meet consumer needs and export demands.

6.1.03 Develop technology for using remotely sensed data to assess and maintain the condition of our natural resources and to provide information for management models and practices.

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